Data in Defense of Codes

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The Presenters Wish to Thank Their Co-Analysts

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Basic Problem

- Your state is considering adoption of a new or improved energy code.
- You want to know what the impacts will be.
- And you want this information from an objective, neutral source.

Typical Request

- You ask DOE to provide you with direct technical assistance from the Building Energy Codes Program (BECP).

- Specifically, you ask "How much energy will a new code save in my state and how much will a new code impact the cost of construction in my state?"

Typical Response

- DOE agrees to fund your request and directs BECP to answer your question.

- BECP proceeds to inundate you with questions about what you really want and how much information you already have on hand.

HELP!

- What does BECP want?
- Why are they asking all these questions?

What BECP Wants

- BECP staff want to zero in on the specific questions you want answered.

- Every state is different, every code adopting body with a state has different perspectives.

- BECP wants to provide you answers to your questions in a way that helps you adopt better energy codes.

Why Does BECP Ask So Many Questions?

- BECP believes that locally gathered and available knowledge is infinitely preferable to the assertions of DOE and national lab staff.

- BECP wants to identify any information you can bring to the table in this analysis and also figure out exactly what analysis you need.

REMEMBER

- When the time comes for your state's code adoption hearings, meetings, or testimony, DOE will not be there. You will.

- DOE wants its reports to be understandable (to you and your audience), based on as much information specific to your state (as possible), and as useful as we can make them.

That Being Said

- DOE can prepare an analysis for you without input from states.

HOWEVER

- The more information we have from you, the better the report will typically be.

Basis of All Energy and Economic Analyses

Base Case – Target Case = Savings

But How Do You Pick Base or Target Cases?

- Base case is typically based on:
  - A specified energy code or standard
  - A report on current practice in your state or region

- Target cases are typically based on:
  - A specified energy code or standard that you are considering for adoption

Base/Target Case Example

For the Massachusetts commercial analysis done by BECP in 1996

- *Base Case was ASHRAE Standard 90.1-1989 with some state modifications*
- *One target case was ASHRAE Standard 90.1-1999 with the 1998 IECC envelope requirements*

Note that this target case is a hybrid of two national model codes.

Important Base/Target Points

- Your state has only one base case – what is being done now.
- Your state may have multiple options as targets – what codes you are thinking of adopting.

  Example – you might consider adopting the 2000 IRC, the 2000 IECC, the 2001 IECC, or NFPA 5000 with ASHRAE 90.2-2001 for homes. Your current code is the 1992 MEC.

What DOE can do for you in terms of base/target cases?

- Help identify your base case
- Help identify recommended target cases through its determination process
- Inform you of upcoming changes in national model codes

Energy Impact Estimation

- Data Needs
- Data Sources
- Tools

Energy Data Needs

- **Building Types**
  - Which ones are important? (politically or otherwise)
  - How fast are they being built in your state? (square footage or number)
  - What do they look like? (number of stories, amount of glazing, footprint)
- **Building Locations**
  - Which ones are important? (politically or otherwise)
  - Where are the buildings being built?

Energy Data Needs

- Building type information is needed for the actual energy simulations we will do that require specific inputs like window area, orientation, wall and roof R-values, construction type, glazing SHGC, number of stories, footprint, etc, etc, etc
- Building location is needed to pick the weather data used in the simulations.

Energy Data Needs

- The more building specific data we have, the better. UP TO A POINT.

- There are limits (time and money) to how many combinations, permutations, and variations we can simulate.

- We need your assistance in picking the best combinations for your needs.

Energy Data Sources

- Where do we get all this data?
  - National sources like CBECS, RECS, and NAHB or Federal studies for building data. TMY, TMY2, WYEC, and other NWS data for climates
  - Regional surveys of current practice
  - State surveys of current practice
  - Your knowledge or the knowledge of your advisory groups or consultants
- We know a lot of sources, but not necessarily all of them.

Energy Data Sources

- Any data is better than no data.
- State data is better than national data.
- Any published data that can be referenced lends credence to the analysis.

Energy Data Sources Example

For BECP's Massachusetts study, data for multifamily apartment buildings was based on verbal description from Tom Reilly at the request of Mark Halverson who asked Tom to "just walk around the outside of your office, look at the apartments, and tell us what type of apartment building you want us to model."

Energy Tools

- BECP uses a variety of simulation tools to predict energy savings.

- Depending on the analysis, we may use BLAST or DOE-2 for commercial work and BRES, RESFEN, and Energy-10 for residential work.

- Future of commercial work is likely to be with EnergyPlus, DOE's newest simulation tool based on the "best of" DOE-2 and BLAST.

# Energy Tools

- BECP also utilizes a lot of custom processing tools to manage simulations, extract results, and aggregate across simulations.

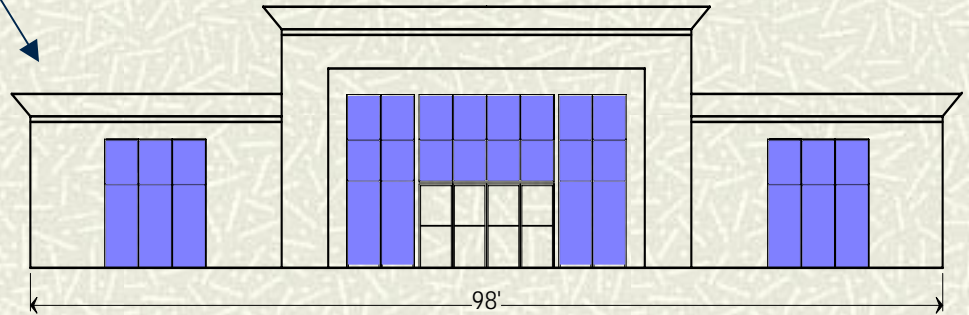- Bottom line on energy simulation tools is that we will use the most appropriate tools for you.

Linking Energy and Economic Analysis

Energy Simulation (BLAST)
Building Prototype ("Gumby")

Economic Analysis
Building Prototype
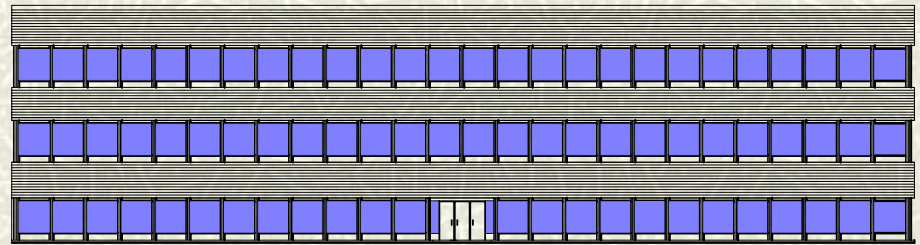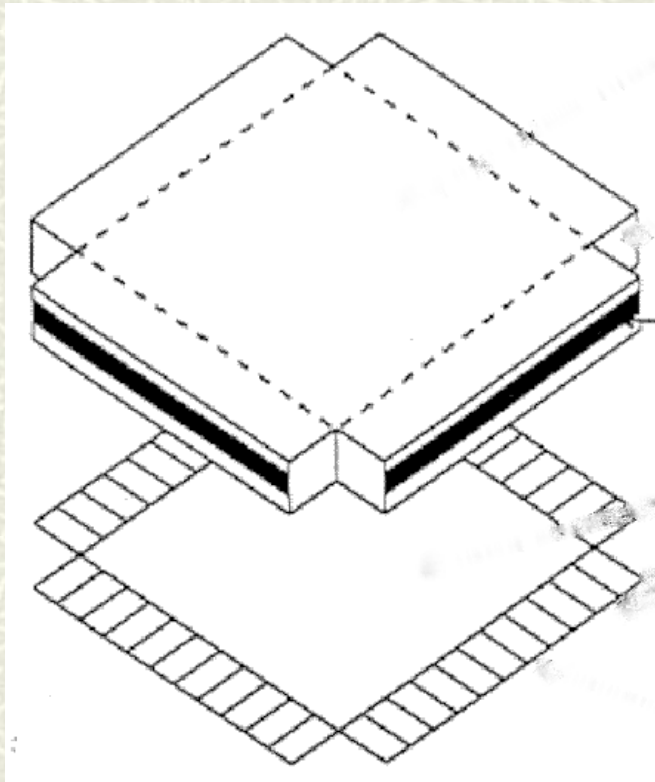
3-story office building with 38% window-to-wall ratio

Single story retail building with 7% window-to-wall ratio

Economic Impact Evaluation

- Data Needs
- Data Sources
- Tools

Economic Data Needs

- Building Material (costs and general information)
  - Windows and coatings
  - Lighting design, controls
- Utility Rates
- Discount Rates
- Building Stock
  - Building Types (e.g. office, retail, education)
  - Growth rates/Regional growth

Economic Data Needs

- Codes are typically opposed on the basis that they would "cost too much."
- It would be helpful to know more about the cost numbers on which the opponents of the code are basing their conclusions
  - Example: If the construction industry opposes the codes claiming that the "windows" required by the code would be cost prohibitive, we would like to know this (and get the cost data if it exists).
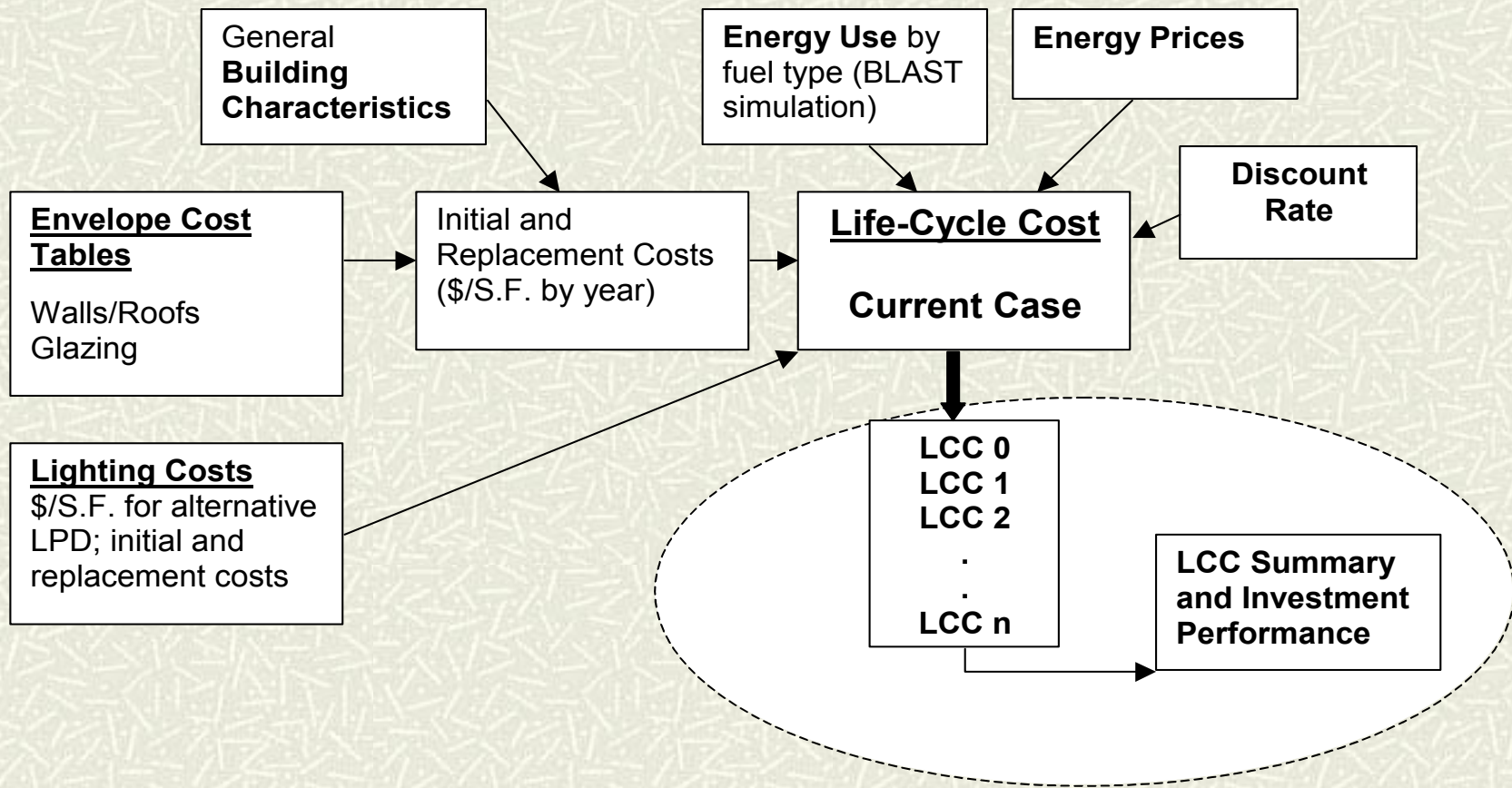
Economic Data Sources

- ASHRAE developed cost datasets (building materials)
- RS Means cost datasets (building materials)
- LBNL Lighting cost dataset (in support of Lighting Ballast Rule)
- DOE's Energy Information Administration (EIA) (utility rates, escalation rates)
- National Institute of Standards and Technology (NIST) (escalation rates)
- Office of Management and Budget (OMB) (discount rates)
- U.S. Census (building types and stock, regional growth)

Other Economic Data Sources

- Regional surveys of construction cost
- State surveys of construction cost
- Your knowledge or the knowledge of your advisory groups or consultants

- We know a lot of sources, but not necessarily all of them.

Economic Tools

General **Building Characteristics**

Energy Use by fuel type (BLAST simulation)

Energy Prices

Discount Rate

Envelope Cost Tables

Walls/Roofs
Glazing

Initial and Replacement Costs ($/S.F. by year)

Life-Cycle Cost

Current Case

Lighting Costs
$/S.F. for alternative LPD; initial and replacement costs

LCC 0
LCC 1
LCC 2
.
.
LCC n

LCC Summary and Investment Performance

Example Analyses

- Residential for States
- Commercial for States
- DOE Determinations

Results Table – Illinois Study

Small Office (WWR=0.18)
Wall Type: Metal Frame
Bldg. Size: 10,000 sq. ft.

			Standard Level			
			90.1-1989 Base	90.1-1999 Envelope Only	90.1-1999 Lighting Only	90.1-1999 Envelope & Lighting
Envelope	**Area (sq. ft.)**					
Windows	1,014	U-factor(std)	0.580	0.570		0.570
		sh. coef.(std)	0.710	0.453		0.453
(Window-Wall Ratio = 0.18)		U-factor(cost)	0.59	0.571		0.571
		sh. coef.(cost)	0.709	0.453		0.453
		cost ($/sqft)	$6.33	$7.38		$7.38
Opaque Walls	4,619	U-factor	0.077	0.084		0.084
		cost ($/sqft)	$0.78	$0.70		$0.70
Roof	10,000	U-factor	0.053	0.063		0.063
		cost ($/sqft)	$1.32	$1.13		$1.13
	(feet)					
Slab perimeter	433	U-factor	0.125	not req'd		not req'd
		cost ($/ft)*	$2.08	$2.08		$2.08
	*24-inch depth					
Envelope Cost (incremental)			$24,131	$22,029		$22,029

Results Table (continued)

		Standard Level		
	90.1-1989 Base	90.1-1999 Envelope Only	90.1-1999 Lighting Only	90.1-1999 Envelope & Lighting

		90.1-1989 Base	90.1-1999 Envelope Only	90.1-1999 Lighting Only	90.1-1999 Envelope & Lighting
Lighting					
Lighting Power Density	watts/sqft	1.63		1.30	1.30
Lighting Cost	$/sqft	$1.57		$1.76	$1.76
Total Lighting Cost		$15,720		$17,554	$17,554
Construction Cost		$39,851	$37,749	$41,685	$39,584
Annual Energy Consumption					
Electricity, lights and plugs	MMBtu	321	321	281	281
Electricity, HVAC	MMBtu	116	100	103	88
Natural Gas	MMBtu	74	88	86	103
Total Annual Energy Cost		$8,954	$8,732	$8,013	$7,819
Economic Measures					
Life-Cycle Cost Savings			$4,695	$8,924	$13,254
Savings-to-Investment Ratio (SIR)			Invest. < 0	4.4	23.2
Adjusted IRR			Invest. < 0	11.0%	15.8%

Notes:
1 **No economizer used**
2 **2001 electricity price = 6.6 cents/kWh**   **2001 gas price = $6.71 /MMBtu**
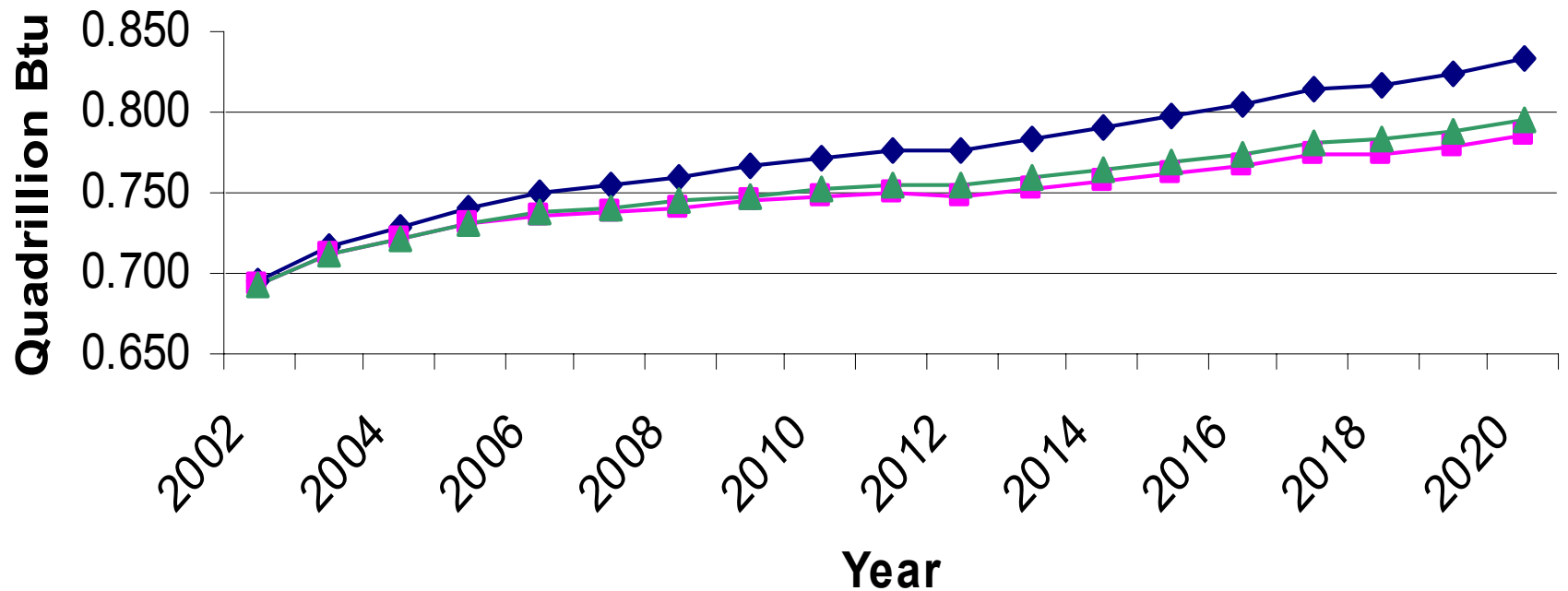3 **Years for Analysis = 40**   **Discount Rate = 7.0%**

LCC Savings per SF by Building Type

LCC Savings per Square Foot by Building Type
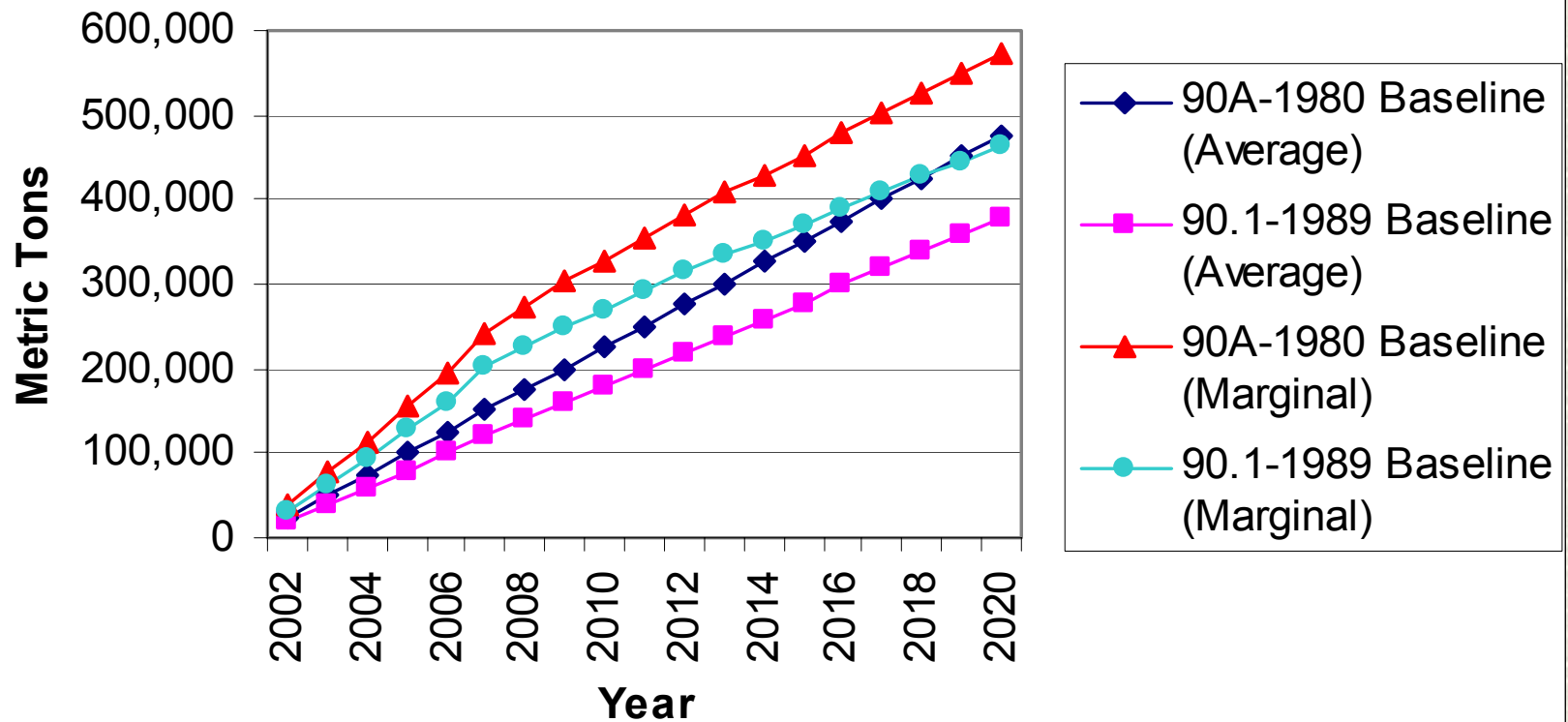**(Illinois, ASHRAE 90.1-1989 to ASHRAE 90.1-1999)**
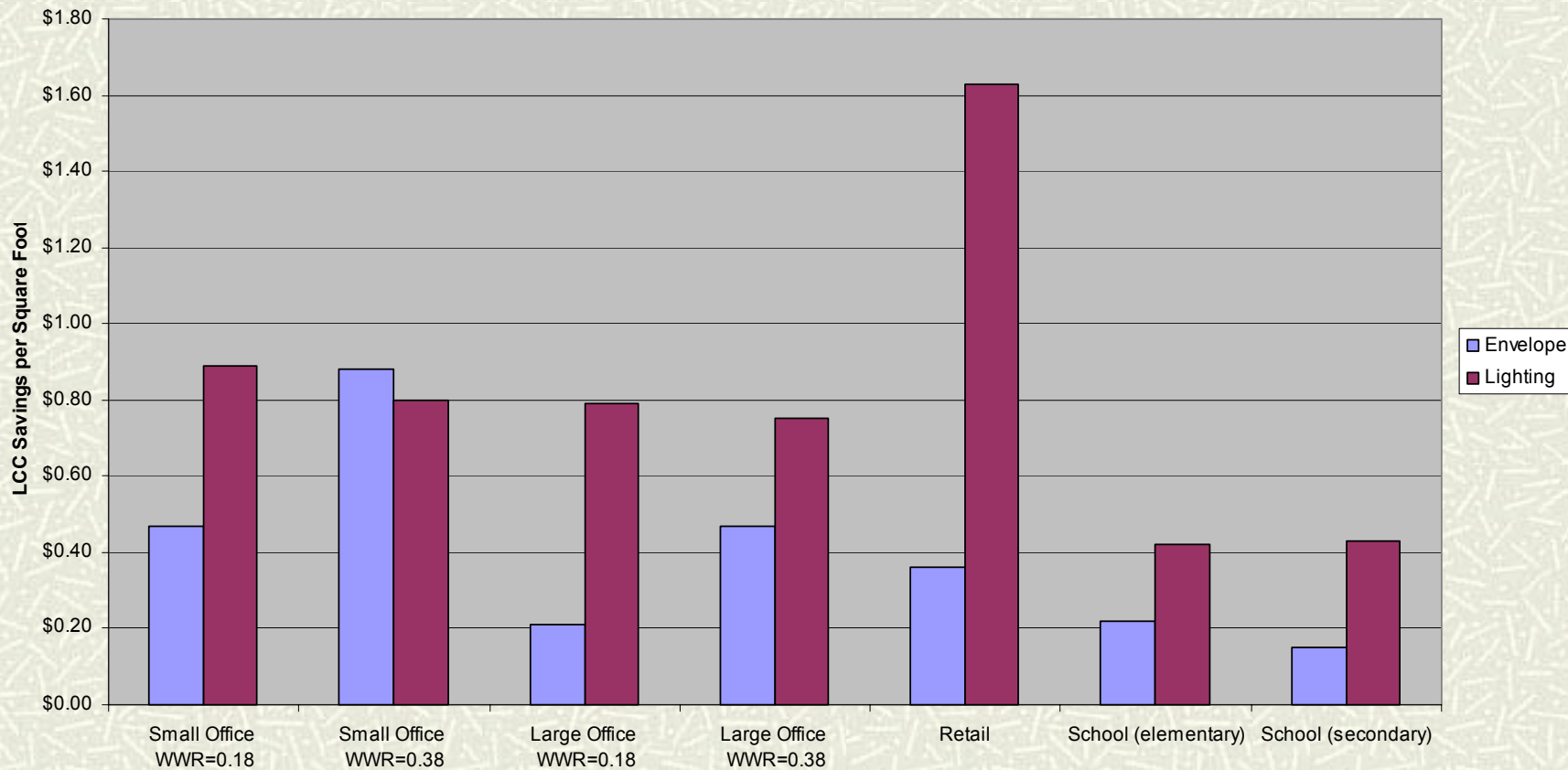
Statewide Impacts – Primary Energy

Statewide Impacts -- Emissions

Estimation of Carbon Emissions Reduction (using marginal and average coefficients) from Adopting Energy Codes in Illinois

Results – Illinois Residential
Annual Energy Saving Per New House

	Aurora			Springfield		
	Heating	**Cooling**	**Total**	**Heating**	**Cooling**	**Total**
Current Practice	$708	$355	$1063	$643	$469	$1112
IECC	$539	$263	$802	$544	$359	$904
Total Savings From IECC	$169	$92	$261	$99	$110	$208
Percent Savings	24%	26%	25%	15%	23%	19%

BECP Residential Analyses

- Indiana 1995
- Maryland 1995
- New Jersey 1995
- Colorado 1995
- Kansas 1996
- Massachusetts 1996
- North Carolina 1996, 1997
- Ohio 1996
- South Carolina 1997
- West Virginia 1997

- New Mexico 1997,1998, and 2001
- New Hampshire 1998
- New York 2000
- Pennsylvania 2000
- Idaho 2001
- Kentucky 2001
- Illinois 2002
- Iowa 2002

BECP Commercial Analyses

- Maryland 1995
- Kansas 1996
- Massachusetts 1996
- Louisiana 1997
- Idaho 1999
- Kentucky 2000
- Texas 2000

- Florida 2001
- New Mexico 2001
- Illinois 2002*
- Iowa 2002*
- Michigan 2002*

* New style economic impact

DOE Determinations

- 1998 and 2000 IECC Determination (res)
  - January 2001
- ASHRAE 90.1-1999 Determination (com)
  - Summer 2002?

- More information at www.energycodes.gov

Conclusion

- The more information you can provide, the better our analysis report can be.

- The more involved in the analysis you are, the better you can understand and convey the results to other stakeholders.